<table>
<thead>
<tr>
<th>Section O: Structures</th>
<th>Effective Date: 01-01-20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Revision #: 2</td>
</tr>
</tbody>
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- **O 1** Fiberglass Manholes/ Sanitary Sewer
- **O 2** Fiberglass Manhole Liners/ Sanitary Sewer
- **O 3** Fiberglass Wet Well Liners/ Sanitary Sewer
- **O 4** Multi-Component Stress Panel Liner System/ Sanitary Sewer
- **O 5** Polymorphic Resin Liner System/ Sanitary Sewer
- **O 6** Precast Manholes
  - **O 6.1** Precast Wet Well
  - **O 6.2** Precast Valve Vaults
O 1 – FIBERGLASS MANHOLE/ SANITARY SEWER:

SPECIFICATION:
Fiberglass manholes shall meet or exceed the performance specifications of:

- Shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins with fiberglass reinforcements specifically manufactured for use with sewage.
- Shall be a one-piece unit.
- Shall have no vertical seams.
- Shall meet ASTM Standards D 3753, Fiber-glass Reinforced Polyester Manholes and Wet Wells.
- Reinforcing material shall be Grade “E” type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.
- The inter surface shall be a resin-rich layer of 0.010 to 0.020 inches thick.
- The concentric cone section shall be affixed to the barrel section at the factory with resin-glass reinforced joint resulting in a one-piece unit.
- The manhole wall thickness shall not be less than 0.50 (1/2") inches.
- Shall provide an area for which a grade ring or brick can be installed to accept a typical metal ring & cover and have strength to support a traffic load without damage to the manhole.
- As a UV inhibitor the resin on the exterior surface shall have a color pigment added for a minimum thickness of .125 inches.
- Stub out connections shall be made by using a fiberglass reinforced pipe stub out as a sealing surface for an approved manhole connection boot.
- Invert and bench area can be either a noncorrosive material completely enclosed in a minimum 1/4-inch layer of fiberglass chop or concrete coated with an approved coating.
- Shall have a minimum dynamic-load rating of 16,000 lbs. (AASHTO HS-20) when tested in accordance with ASTM D 3753 and shall not leak, crack or suffer other damage when load tested to 40,000 lbs.

SPECIFICATION (CONT.)
- Shall meet or exceed NBS PS 15-69 physical properties as listed in table 1, of that standard:
  - Ultimate Tensile Strength (psi) 15,000
  - Flexural Strength (psi) 22,000
  - Flexural Modulus or elasticity (psi) 1,000,000
- Shall have a concrete base, 8” thick when less than 12’ deep and 12” thick when more than 12’ deep.
- The base shall extend a minimum of 1 foot from the outside wall of the manhole.
- The base shall be sized to act as an anti-floatation device for the entire unit.
- Shall be sized per construction drawings.
- Affidavit of compliance to this specification shall be available upon request.

IDENTIFICATION:
Each manhole shall be marked inside and out with the following information:

- Manufactures name and trademark
- Manufactures factory location
- Manufactures serial number or date code
- Total length or nominal diameter
<table>
<thead>
<tr>
<th>O 1 – CONTINUED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANUFACTURER:</td>
</tr>
<tr>
<td>• CONTAINMENT SOLUTIONS, INC.</td>
</tr>
<tr>
<td>• L.F. MANUFACTURING, INC.</td>
</tr>
<tr>
<td>• OPEN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESTRICTIONS:</th>
</tr>
</thead>
</table>
SPECIFICATION:
Fiberglass manhole liners shall meet or exceed the performance specifications of:

- Shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins with fiberglass reinforcements specifically manufactured for use with sewage.
- Shall be a one-piece unit.
- Shall have no vertical seams.
- Shall meet ASTM Standards D 3753, Fiber-glass Reinforced Polyester Manholes and Wet Wells.
- Reinforcing material shall be Grade “E” type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.
- The inter surface shall be a resin-rich layer of 0.010 to 0.020 inches thick.
- The concentric cone section shall be affixed to the barrel section at the factory with resin-glass reinforced joint resulting in a one-piece unit.
- The liner wall thickness shall not be less than 0.50 (1/2”) inches.
- Shall provide an area for which a grade ring or brick can be installed to accept a typical metal ring & cover and have strength to support a traffic load without damage to the manhole.
- As a UV inhibitor the resin on the exterior surface shall have a color pigment added for a minimum thickness of 0.125 inches.
- Shall have a minimum dynamic-load rating of 16,000 lbs. (AASHTO HS-20) when tested in accordance with ASTM D 3753 and shall not leak, crack or suffer other damage when load tested to 40,000 lbs.
- Shall meet or exceed NBS PS 15-69 physical properties as listed in table 1, of that standard:
  - Ultimate Tensile Strength (psi) 15,000
  - Flexural Strength (psi) 22,000
  - Flexural Modulus or elasticity (psi) 1,000,000
- Shall be sized per construction drawings.

SPECIFICATION (continued)
- Pipe entering through the manhole wall with an invert equal to or higher than the bench will be sealed all around the interior wall by use of a fiberglass patch kit. There will be no exposed mortar above bench or fillet level.
- Affidavit of compliance to this specification shall be available upon request.

IDENTIFICATION:
Each manhole liner shall be marked inside and out with the following information:

- Manufactures name and trademark
- Manufactures factory location
- Manufactures serial number or date code
- Total length or nominal diameter

MANUFACTURER:
- CONTAINMENT SOLUTIONS, INC.
- L.F. MANUFACTURING, INC.
- OPEN

RESTRICTIONS:
- Rehabilitation only.
**SPECIFICATION:**
Fiberglass wet well liners shall meet or exceed the performance specifications of:

- Shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins with fiberglass reinforcements specifically manufactured for use with sewage.
- Shall be a one-piece unit.
- The wet good liner pipe shall have plain ends and have no vertical seams.
- Fiberglass tops and hatch openings shall be provided.
- Shall meet ASTM Standards D 3753, Fiber-glass Reinforced Polyester Manholes and Wet Wells.
- Reinforcing material shall be Grade “E” type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.
- The interior surface shall be a resin-rich layer of 0.010 to 0.020 inches thick.
- The liner wall thickness shall not be less than 0.625 (5/8") inches.
- As a UV inhibitor the resin on the exterior surface shall have a color pigment added for a minimum thickness of 0.125 inches.
- Shall have a minimum dynamic-load rating of 16,000 lbs. (AASHTO HS-20) when tested in accordance with ASTM D 3753 and shall not leak, crack or suffer other damage when load tested to 40,000 lbs.
- Shall meet or exceed NBS PS 15-69 physical properties as listed in table 1, of that standard:
  - Ultimate Tensile Strength (psi) 15,000
  - Flexural Strength (psi) 22,000
  - Flexural Modulus or elasticity (psi) 1,000,000
- Shall be sized per construction drawings.

**SPECIFICATION (continued):**
- Pipe entering through the wet well wall with an invert equal to or higher than the bench will be sealed all around the interior wall by use of a fiberglass patch kit.
- Affidavit of compliance to this specification shall be available upon request.

**IDENTIFICATION:**
Each wet well liner shall be marked inside and out with the following information:

- Manufacture name and trademark
- Manufacture factory location
- Manufacture serial number or date code
- Total length or nominal diameter

**MANUFACTURER:**
- CONTAINMENT SOLUTIONS, INC.
- L.F. MANUFACTURING, INC.
- OPEN

**RESTRICTIONS:**
- Diameters of 5’ or less.
**SPECIFICATION:**
Multi-layered poly resin composite protective manhole and wet well liner system shall meet or exceed the performance specifications of:

- Shall provide a waterproof, corrosion resistant liner to prevent any deterioration of concrete surfaces from hydrogen sulfide and other corrosive gases/ acids produced by wastewater.
- Manufacture shall warrant material and workmanship for a minimum period of ten (10) years.
- Shall be a non load-bearing component.
- To ensure total unit responsibility, all material and installation shall be furnished by, and coordinated with, one supplier/ manufacturer.
- The interior surfaces to be protected shall include the walls, ceiling, benches and pipe entries.
- Total thickness of multi-component stress panel liner shall be a minimum of 500 mils and shall sustain a 300 PSI pull test.
- Use of this system is restricted to rehabilitation of existing structures.

**PHYSICAL/ MATERIAL PROPERTIES:**

1. Liner
   - Installation: Moisture barrier
   - Surface: Modified Polymer
   - Final corrosion barrier: Modified polymer

2. Modified polymer shall be sprayable, solvent free, two-component polymeric, moisture/ chemical barrier specifically developed for the corrosive wastewater environment.

**TYPICAL CHEMICAL ANALYSIS**

**“A” Component**
- Viscosity, 77°F, cps., ASTM D-1638: 300-400
- Physical State: Liquid
- Color: Color to amber
- Hygroscopicity: Reads with water

**“B” Component**
- Viscosity, 160°F, cps., ASTM D-1638: 400-600
- Physical State: Liquid
- Color: Flamingo Pink
- Non-Volatile: 100%

**Reaction Profile (100 grams, 77°F sample)**
- Gel Time, seconds: 1-3
- Tack Free Time, seconds: 15
- Cure Time, seconds: 30
- Processing: A System / B System, volume ratio 1.00 / 1.00

**PHYSICAL MATERIAL PROPERTIES (continued):**

Typical Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, PSI</td>
<td>&gt; 1500</td>
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<tr>
<td>Elongation, %</td>
<td>&gt; 325</td>
</tr>
<tr>
<td>Tear Strength, PSI</td>
<td>&gt; 250</td>
</tr>
<tr>
<td>Impact Strength, ft-lb</td>
<td>&gt; 8.0</td>
</tr>
<tr>
<td>100% Modulus, PSI</td>
<td>&gt; 1500</td>
</tr>
</tbody>
</table>

3. Polyurethane Rapid Structure Foam, low viscosity two-component, containing flame retardants.

**TYPICAL CHEMICAL ANALYSIS**

**“A” Component**
- Viscosity, 77°F, cSs., ASTM D-1638: 200
- Physical State: Liquid
- Color: Dark Brown
- Hygroscopicity: Reacts with water and evolves CO2 gas

**“B” Component**
- Viscosity, 77°F, cSs., ASTM D-1638: 600-1000
- Physical State: Liquid
- Color: Tan
- Hygroscopicity: Absorbs water rapidly

**Reaction Profile (100 grams, 77°F sample)**
- Cure Time, seconds: 1-4
- Tack Free Time, seconds: 5-8
- Cure Time, seconds: 6-10
- Processing: A System / B System, volume ratio 1.00 / 1.00

**Typical Physical Properties**
- Density, nominal, core, lb/ft³ ASTM D-1622 @ 74°F: 4-10
- Compression Strength, ASTM D-1621 @ 74°F parallel, psi: 90-150
- Closed Cell Content, % - ASTM 1562 @ 74°F: 85-90
- Shear Strength, PSI - ASTM C-273 @ 74°F: 225-250

**MANUFACTURER:**
- CONCRETE CONSERVATION, INC.
- SPECTRA-SHIELD
- OPEN

**RESTRICtIONS:**
**O 5 – POLYMORPHIC RESIN LINER SYSTEM / SANITARY SEWER:**

**SPECIFICATION:**
Polymorphic resin protective manhole and wet well liner system shall meet or exceed the performance specifications of:

- Manufacture shall warrant material and workmanship for a minimum period of ten (10) years.
- Shall be a modified isophthalic polyester liner system made of two-components, 100% solid, known as polymorphic resin as described below.
- Shall provide a waterproof, corrosion resistant liner to prevent any deterioration of concrete surfaces from hydrogen sulfide and other corrosive gases/acids produced by wastewater.
- Can be used to rehabilitate and protect concrete, steel, fiberglass, or masonry surfaces.
- System shall restore structural integrity of brick/concrete structures.
- Shall use an approved quick setting cementitious material to bring substrate to profile.
- To ensure total unit responsibility, all material and installation shall be furnished by, and coordinated with, one supplier/manufacturer.
- The resin based material shall be used to form the sprayed on/structure enhanced monolithic liner covering all interior surfaces to be protected and shall include the walls, ceiling, benches, inverts and pipe entries.
- Application of liner system shall be in strict accordance with manufacture’s recommendation.
- The three coat system is made of a prime coat (DS-101 10-25 mils thick), intermediate coat (DS301 75-150 mils thick), and a final coat (DS-401 10-25 mils thick). Final installation shall be a minimum thickness of 150 mils and not more than 250 mils thick.

**MINIMUM PHYSICAL/MATERIAL PROPERTIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength</td>
<td>ASTM D790</td>
<td>8,630 psi</td>
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<tr>
<td>Compressive Strength</td>
<td>ASTM D695</td>
<td>15,120 psi</td>
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<tr>
<td>Tensile Strength</td>
<td>ASTM D638</td>
<td>4,900 psi</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>Impressor #L25</td>
<td>72-75</td>
</tr>
<tr>
<td>Adhesive Strength</td>
<td>Direct to Metal</td>
<td>1,582 psi</td>
</tr>
</tbody>
</table>

**MANUFACTURER:**
- ZEBRON 386
- OPEN

**RESTRICTIONS:**
O 6 – PRECAST MANHOLES:

SPECIFICATION:

- Precast manhole shall meet or exceed the performance specifications of ASTM C478 & C913 for round structures.
- Openings shall be manufactured per ASTM C76, coring shall be specified per plans.
- Structure to be watertight and resist buoyant force.
- Standard manhole precast riser sections shall not exceed 4-feet; larger pump station wet well sections may be approved.
- Concrete shall conform to:
  - Compressive strength 4,000 psi @ 28-days
  - Air content 4% min.
  - Aggregate: ASTM C33
  - Cementitious materials: minimum of 564 lbs./yd3.
  - Free of organic impurities.
- Manholes 4-feet deep or less shall have an eccentric cone or a flat top.
- Manholes over 4-feet deep shall have an eccentric cone.
- Manholes shall have a minimum inside diameter of 4-feet for sewer mains 12-inches and smaller.
- Manholes shall be 5-feet for sewer mains larger than 12-inches.
- 5-foot manholes shall have an 8” extended base.
- 4-foot manholes shall have a 6” extended base.
- Extended bases shall have a minimum thickness of 6-inches.
- Manholes at ground level and located in traffic areas shall have anti-inflow inserts per Section K.
- Lift and handling devices shall have safety factor of 4 or greater.
- Corrosion linings as specified and indicated on design drawings.

SPECIFICATION (continued):

- Vents in remote or outfall areas shall be constructed of aluminum or 316 SST and shall extend a minimum of 2-feet above 100-year flood with integral non-corrosive insect screen.
- Vents in residential neighborhoods and commercial areas require special approval on a case-by-case basis.
- Watertight joints using ASTM C990 preformed flexible sealants.
- Pipe to manhole connections shall conform to ASTM C923 per Section H.
- Cylindrical wall seals per Section K.
- The location of the pipe connectors shall vary from the plans no more than ½-inch vertically and 5-degrees horizontally.

MANUFACTURES:

- OLD CASTLE
- TINDALL
- STAY-RIGHT
- CAPE FEAR PRECAST
- OPEN

RESTRICTIONS:
O 6.1 – PRECAST WET WELL:

SPECIFICATION:
Precast wet wells for pump stations shall meet or exceed the preceding performance specifications of precast manhole with supplemental requirements as indicated below:

- Concrete 5,000 psi compressive strength @ 28-days.
- Minimum wall thickness shall be 5" for 5'-0", 6" for 6'-0" and 8" for 8'-0".
- Provide 1-inch cover all reinforcing steel.
- Base section shall include a 1'-0" extended base unless otherwise specified.
- All fasteners, wedge anchors, bolts, and hooks shall be 316 stainless steel.
- Support grip for each float and dower cord shall be “Hubbell” closed mesh series 024-17-xxx.
- Raintight aluminum hatch per design drawings, lockable with matching eye and padlock per Section I.
- Top shall be set as minimum of 2' above 100-year flood EL.
- Subject to leakage testing requirements per specifications.

MANUFACTURES:
OLD CASTLE
TINDALL
STAY-RIGHT
CAPE FEAR PRECAST
OPEN

RESTRICTIONS:
O 6.2 – PRECAST VAULTS:

SPECIFICATION:
Precast concrete valve vaults shall meet or exceed the preceding requirements for precast manholes and with supplement requirements as indicated below:

- Conform to ASTM C913 & C890 for rectangular/square structures.
- Minimum 4’ x 4’ x 4’ with a minimum base thickness of 6” and minimum wall thickness of 5”.
- Live load rating of AASHTO HS20-44.
- Access hatches shall be pad lockable frame and cover, with a ¼” watertight aluminum plate and 1/8” thick x 3” wide 316 stainless steel hinges per Section I.
- Step to be installed 18” below hatch on a non-hinged side.
- Shall be watertight structure. Subject to leakage testing requirements per specifications.

MANUFACTURES:
- OLD CASTLE
- TINDALL
- STAY-RIGHT
- CAPE FEAR PRECAST
- OPEN

REstrictions: